Ocean Backscatter Across the Gulf Stream Sea Surface Temperature Front

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Abstract

Sea surface temperature fronts affect the marine atmospheric boundary layer and influence submesoscale processes in the coastal marine zone. Understanding effects of the temperature fronts has an important impact on coastal navigation, weather forecasting, climate study, and submesoscale to mesoscale ocean circulation. For remote sensing of sea surface temperature fronts with scatterometer, ocean backscatter across the fronts needs to be investigated. During the Surface Wave Dynamics Experiment (SWADE) off the coast of Virginia and Maryland, the Jet Propulsion Laboratory NUSCAT K_u-band scatterometer was flown on the NASA Ames C130 aircraft over the Gulf Stream boundary. Ocean backscatter was measured across the temperature front in several flights for vertical and horizontal polarizations at incidence angles from 10° to 60°. The Fleet Numerical Oceanography Center current field indicated that the north wall of the Gulf Stream curved into the experimental area and the boundary of the temperature front was partially observed in the NOAA AVHRR image over the cloud-free region. Backscatter across the front between NOAA experimental buoy A on the cold side and Discus C buoy on the warm side shows a difference of more than 5 dB. The buoys provide data such as air and sea temperatures, wind speed and direction, stability parameter, atmospheric pressure, directional wave spectrum, and significant wave height for use in the backscatter study. The large frontal backscatter change is observed in all upwind, downwind, and crosswind directions. In this case, the temperature difference measured by the buoys was about 9°C. The corresponding difference in wind speed was 4 m/s, which cannot account for the large backscatter change in view of geophysical model functions depending only on neutral wind velocity such as SASS. The measured backscatter also has larger upwind-downwind and upwind-crosswind ratios compared to the model results in many cases. NUSCAT data also show that upwind backscatter on the cold side was smaller than or close to crosswind backscatter on the warm side for incidence angles between 20° to 50°. This suggests that the sea surface temperature front can be detected by the scatterometer at these incidence angles for different wind directions in the cold and warm sides.